Project Report

# Introduction

Here are the three sections of the technical report, written based on the provided context.  
  
### \*\*Introduction\*\*  
  
Avobenzone is a UV blocker used in sunblock formulations, but its efficacy is limited by its instability and tendency to degrade upon exposure to UV radiation. Enhancing the photostability of avobenzone could prolong its protective effects and reduce the need for frequent reapplication of sunscreen products. This project was initiated to address the challenge of avobenzone's UV-induced degradation. The primary approach attempted was the encapsulation of avobenzone within poly(lactic-co-glycolic acid) (PLGA) microspheres. A series of experiments were conducted to prepare, characterize, and evaluate these microsphere formulations. The work involved foundational spectrophotometric analysis of avobenzone and octocrylene, preparation of microspheres with varying PLGA concentrations, and subsequent studies to assess drug loading, UV degradation protection, and drug release profiles.  
  
### \*\*Summary\*\*  
  
This project successfully evaluated the encapsulation of avobenzone in poly(lactic-co-glycolic acid) (PLGA) microspheres as a method to improve its stability against UV degradation. Spectrophotometric analysis established the maximum absorption peaks for avobenzone at 357 nm and octocrylene at 310 nm. Degradation studies confirmed that avobenzone degrades significantly under UV exposure, while octocrylene remains more stable. Various avobenzone-loaded PLGA microsphere formulations were prepared, achieving drug loading percentages between 41% and 49%. Key findings from UV exposure tests indicated that certain PLGA concentrations offered enhanced protection for avobenzone; specifically, formulations with 10% (AV15) and 20% (AV12) PLGA demonstrated the most promise in reducing degradation. Drug release studies showed that release profiles varied by formulation, with cumulative release over 56 hours reaching 74% for AV15 and 113% for AV10. The results suggest that PLGA microsphere encapsulation is a viable strategy for stabilizing avobenzone, with specific formulations identified for further optimization and analysis.  
  
### \*\*Objectives\*\*  
  
The specific objectives of this project were as follows:  
  
1. To determine the maximum absorption peaks of avobenzone and octocrylene in dimethyl sulfoxide (DMSO) and ethanol solvents.  
2. To measure the degradation of avobenzone, both individually and in combination with octocrylene, after exposure to UV radiation.  
3. To prepare avobenzone-loaded PLGA microsphere formulations with increasing concentrations of PLGA.  
4. To evaluate the prepared microsphere formulations based on their microsphere yield and drug loading percentages.  
5. To assess the protective effect of PLGA microsphere encapsulation on the stability of avobenzone when subjected to UV exposure.  
6. To perform drug release studies to assess the amount and rate of avobenzone released from the microsphere formulations over time.

# Methodology

\*\*Methodology\*\*  
  
### Materials  
The chemical compounds used in this study were avobenzone, octocrylene, and poly(D,L-lactide-co-glycolide) (PLGA; Viatel DLG 7502E, 75:25 lactide:glycolide, ester end-cap). Solvents included dimethyl sulfoxide (DMSO), ethanol, dichloromethane (DCM), and deionized water. General laboratory equipment consisted of an analytical balance, vortex mixer, timer, spatula, micropipettes with corresponding tips, and 1.5 mL and 2.0 mL centrifuge tubes. Sample incubations and measurements were performed using Costar 24-well plates and Greiner UV half-area 96-well plates.  
  
### Preparation of Test Articles  
  
#### Solutions of UV Filters  
Stock solutions of avobenzone (1 mg/mL) and octocrylene (1 mg/mL and 3 mg/mL) were prepared by dissolving the accurately weighed compounds in either DMSO or ethanol. For degradation studies, diluted solutions were prepared from these stocks. A 0.1 mg/mL avobenzone solution was prepared via a 1:10 dilution of the 1 mg/mL stock with DMSO. Similarly, a 0.3 mg/mL octocrylene solution was made by a 1:10 dilution of the 3 mg/mL stock with DMSO. Mixed solutions containing both avobenzone and octocrylene were prepared at concentrations of 0.5 mg/mL each, 0.1 mg/mL avobenzone with 0.3 mg/mL octocrylene, or 0.2 mg/mL each, by combining the appropriate stock solutions and diluting with DMSO.  
  
#### Avobenzone-Loaded PLGA Microspheres  
Avobenzone-loaded microspheres were prepared to evaluate the protective effects of encapsulation. Multiple formulations, designated AV7 through AV16, were synthesized by dissolving avobenzone and PLGA polymer in dichloromethane (DCM). To investigate the impact of polymer concentration on drug stability, formulations were prepared with PLGA concentrations ranging from 52.5 mg/mL to 65 mg/mL, representing a 5% to 30% increase over a baseline concentration. The specific masses of avobenzone, PLGA, and the volume of DCM used for each formulation are detailed in [TABLE\_1]. The resulting drug loading for the prepared microspheres ranged from approximately 41% to 49% (w/w).  
  
\*\*Table 1: Formulation parameters for the preparation of avobenzone-loaded PLGA microspheres.\*\*  
  
| Codename | Formulation Code | Dispersed Phase Drug (mg) | Dispersed Phase PLGA (mg) | Dispersed Phase Solvent | Dispersed Phase Solvent Volume (uL) |  
| :--- | :--- | :--- | :--- | :--- | :--- |  
| Ava | AV10 | 50.7 | 52.5 | DCM | 1000 |  
| Ava | AV11 | 50.7 | 55.0 | DCM | 1000 |  
| Ava | AV12 | 50.5 | 60.0 | DCM | 1000 |  
| Ava | AV13 | 50.8 | 65.0 | DCM | 1000 |  
| Ava | AV14 | 50.9 | 52.5 | DCM | 1000 |  
| Ava | AV15 | 50.6 | 55.0 | DCM | 1000 |  
| Ava | AV16 | 50.4 | 60.0 | DCM | 1000 |  
  
### Spectroscopic Characterization and Degradation Analysis  
  
#### Absorbance Scans and Wavelength Selection  
To determine the maximum absorbance wavelength (λmax) for the UV filters, initial spectroscopic scans were performed. Stock solutions of avobenzone and octocrylene were prepared in DMSO and ethanol, loaded into a 96-well plate, and serially diluted. The absorbance spectra were recorded from 230 nm to 425 nm using a Tecan Spectrophotometer. These scans confirmed that avobenzone has a λmax at 357 nm, while octocrylene has a λmax at 310 nm [FIGURE\_1]. Based on these results and the experimental goals, a wavelength of 365 nm was selected for all subsequent degradation studies to specifically monitor avobenzone.  
  
\*\*Figure 1: Absorbance spectrum of serially diluted octocrylene in DMSO, showing a maximum absorption peak at 310 nm.\*\*  
  
#### UV-Induced Degradation Studies  
The photodegradation of avobenzone, both in solution and within microspheres, was assessed using three different UV radiation sources: natural sunlight, a 5.0 UVB lamp apparatus, and a Formlabs UV Cure Chamber. For each experiment, samples were aliquoted into the wells of a Costar 24-well plate. A corresponding control plate was prepared identically but was kept in a dark environment for the duration of the experiment to account for any degradation not induced by UV light.  
  
For solution-based studies, 250 µL aliquots of the prepared UV filter solutions were exposed to a UV source. Absorbance measurements were taken at discrete timepoints, ranging from 10-minute intervals up to 150 minutes, or over longer periods up to 24 hours, to generate degradation profiles [TABLE\_2] and [FIGURE\_2].  
  
\*\*Table 2: Absorbance of 0.1 mg/mL avobenzone in DMSO at 365 nm following UV exposure in a Formlabs Cure Chamber at discrete timepoints, compared to a non-exposed control.\*\*  
  
| Minutes | Timepoint | UV Radiated 365nm Abs. | Control 365nm Abs. |  
| :--- | :--- | :--- | :--- |  
| 0 | To | 12.0870 | 12.2270 |  
| 10 | T1 | 5.4360 | 12.1930 |  
| 20 | T2 | 3.6020 | 11.9470 |  
| 30 | T3 | 8.5160 | 11.7160 |  
| 40 | T4 | 5.2810 | 11.5370 |  
| 50 | T5 | 4.6700 | 11.4930 |  
| 60 | T6 | 5.0220 | 11.5070 |  
| 70 | T7 | 4.8260 | 11.3850 |  
| 80 | T8 | 4.9940 | 11.2630 |  
  
\*\*Figure 2: Degradation profile of UV-exposed avobenzone solution and an avobenzone-octocrylene mixture in DMSO.\*\*  
  
For microsphere degradation studies, a pre-weighed mass of a specific formulation (e.g., 2.5 mg to 5.0 mg) was placed into each well prior to UV exposure [TABLE\_3]. After the designated exposure time, the microspheres were recovered by rinsing the well with 2 mL of deionized water into a centrifuge tube. The suspension was centrifuged at 15,000 rcf for 10 minutes to pellet the microspheres. The aqueous supernatant was decanted, and the pellet was fully dissolved in a known volume of DMSO to achieve a target concentration suitable for spectrophotometric analysis. The resulting degradation profiles were plotted to assess the protective effect of the microsphere encapsulation [FIGURE\_3].  
  
\*\*Table 3: Experimental design for the UV degradation study of avobenzone-loaded microspheres with varying PLGA concentrations.\*\*  
  
| Formulation # | PLGA [C] Increase | Drug Loading % | Mass per well | Timepoints |  
| :--- | :--- | :--- | :--- | :--- |  
| AV14 | +5% | 43.02% | 2.5 mgs/well | 0, 10, 20, 30, 40, 50 min |  
| AV15 | +10% | 41.93% | 5 mgs/well | 0, 10, 20, 30, 40, 50 min |  
| AV12 | +20% | 41.39% | 2.5 mgs/well | 0, 10, 20, 30, 40, 50 min |  
| AV13 | +30% | 42.71% | 5 mgs/well | 0, 10, 20, 30, 40, 50 min |  
  
\*\*Figure 3: Degradation profile of avobenzone-loaded microspheres with increased PLGA concentration following UV exposure.\*\*  
  
#### Quantitative Spectrophotometric Measurement  
Quantitative analysis of avobenzone degradation was performed using a Nanodrop OneC Microspectrophotometer. Prior to each measurement series, the instrument was blanked using DMSO. For each sample, a 2 µL aliquot of the solution was pipetted onto the lower measurement pedestal, and the absorbance at 365 nm was recorded. This technique was chosen for its consistency and small sample volume requirement, allowing for repeated measurements from the same well over the experimental time course.

# Results

### \*\*Results\*\*  
  
### Spectroscopic Characterization of Avobenzone and Octocrylene  
  
To establish a baseline for quantitative analysis, the absorbance spectra of avobenzone and octocrylene were measured individually and as a mixture in both dimethyl sulfoxide (DMSO) and ethanol. Spectrophotometric scans were conducted from 230 nm to 425 nm. In DMSO, octocrylene exhibited a maximum absorption peak (λ\_max) at 310 nm [FIGURE 1]. In ethanol, the octocrylene λ\_max was also observed at 310 nm [FIGURE 2].  
  
\*\*Figure 1: Absorbance spectrum of octocrylene in DMSO.\*\*  
\*\*Figure 2: Absorbance spectrum of octocrylene in ethanol.\*\*  
  
Avobenzone showed a distinct λ\_max at 357 nm in both DMSO and ethanol solvents [FIGURE 3, FIGURE 4]. When combined in a 1:1 mixture (0.5 mg/mL each) in DMSO, the resulting spectrum showed two distinct peaks corresponding to the individual components, with the avobenzone peak at 357 nm being more prominent [FIGURE 5]. A similar spectral profile was observed for the mixture in ethanol [FIGURE 6]. The spectra indicated a region of overlap between the decreasing shoulder of the octocrylene peak and the increasing shoulder of the avobenzone peak.  
  
\*\*Figure 3: Absorbance spectrum of avobenzone in DMSO.\*\*  
\*\*Figure 4: Absorbance spectrum of avobenzone in ethanol.\*\*  
\*\*Figure 5: Absorbance spectrum of a mixture of avobenzone and octocrylene in DMSO.\*\*  
\*\*Figure 6: Absorbance spectrum of a mixture of avobenzone and octocrylene in ethanol.\*\*  
  
### Microsphere Formulation and Characterization  
  
A series of avobenzone-loaded microsphere (AV) formulations were prepared using poly(lactic-co-glycolic acid) (PLGA) with varying polymer concentrations relative to a baseline of 50 mg/mL. The formulations were coded AV10 through AV16. The resulting microsphere yield and drug loading percentages were quantified [TABLE 1]. The percent yield of microspheres ranged from 2.91% for formulation AV10 to 45.22% for AV15. The measured drug loading (w/w) was consistent across formulations, ranging from 41.39% (AV12) to 48.79% (AV16).  
  
\*\*Table 1: Formulation characteristics of avobenzone-loaded PLGA microspheres.\*\*  
| Formulation Code | Microsphere Yield (mg) | Theoretical Max Yield (mg) | Percent Yield | Drug Loading % (w/w) | Theoretical Max Drug Loading % |  
| :--- | :--- | :--- | :--- | :--- | :--- |  
| AV10 | 3.0 | 103.2 | 2.91% | 48.37% | 49.13% |  
| AV11 | 18.0 | 105.7 | 17.03% | 47.02% | 47.97% |  
| AV12 | 26.9 | 110.5 | 24.34% | 41.39% | 45.70% |  
| AV13 | 43.2 | 115.8 | 37.31% | 42.71% | 43.87% |  
| AV14 | 21.4 | 103.4 | 20.70% | 43.02% | 49.23% |  
| AV15 | 47.8 | 105.6 | 45.22% | 41.93% | 47.92% |  
| AV16 | 40.1 | 110.4 | 36.33% | 48.79% | 45.65% |  
  
### Photodegradation of Free Avobenzone and Octocrylene under UV Exposure  
  
The photodegradation of unencapsulated avobenzone and octocrylene was evaluated using different UV sources. In an initial experiment, solutions of 0.2 mg/mL avobenzone, 0.2 mg/mL octocrylene, and a mixture of both were exposed to a 5.0 UVB lamp for up to 180 minutes. The absorbance of avobenzone at 365 nm showed a gradual decrease from an initial value of 23.146 to 18.380 after 180 minutes [TABLE 2, FIGURE 7]. The absorbance of octocrylene and the avobenzone-octocrylene mixture showed similar slow degradation profiles over the same period.  
  
\*\*Table 2: Absorbance at 365 nm of solutions exposed to a UVB lamp over 180 minutes.\*\*  
| Standard Solutions | Concentration (mg/mL) | 0 Minutes | 30 Minutes | 60 Minutes | 90 Minutes | 120 Minutes | 180 Minutes |  
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |  
| Avobenzone in DMSO | 0.2 | 23.146 | 21.049 | 20.412 | 19.528 | 18.980 | 18.380 |  
| Octocrylene in DMSO | 0.2 | 0.818 | 0.756 | 0.666 | 0.702 | 0.712 | 0.739 |  
| Avo/Octo in DMSO | 0.2 | 23.700 | 22.063 | 21.550 | 20.069 | 19.764 | 19.033 |  
  
\*\*Figure 7: Degradation profiles of avobenzone, octocrylene, and a mixture under UVB lamp exposure.\*\*  
  
Subsequent experiments utilized a Formlabs UV Cure Chamber as the radiation source. A 0.1 mg/mL solution of avobenzone exposed for 150 minutes showed a rapid decrease in absorbance at 365 nm from 11.776 at T0 to a minimum of 1.213 at 60 minutes (an 89.7% decrease) [TABLE 3, FIGURE 8]. After 60 minutes, the absorbance began to increase, reaching 3.679 by 150 minutes. The non-irradiated control sample showed only a slight, gradual decrease in absorbance over the same period.  
  
\*\*Table 3: Absorbance at 365 nm of 0.1 mg/mL avobenzone solution with and without UV exposure in a Formlabs chamber over 150 minutes.\*\*  
| Timepoint (Minutes) | UV Radiated Abs. | Non-UV Radiated Abs. |  
| :--- | :--- | :--- |  
| 0 | 11.776 | 11.5900 |  
| 15 | 4.106 | 11.1090 |  
| 30 | 2.527 | 10.9780 |  
| 45 | 1.783 | 10.8930 |  
| 60 | 1.213 | 10.7910 |  
| 75 | 1.962 | 10.6940 |  
| 90 | 1.945 | 10.7150 |  
| 105 | 2.265 | 10.5300 |  
| 120 | 2.354 | 10.8100 |  
| 135 | 2.762 | 10.6240 |  
| 150 | 3.679 | 10.4750 |  
  
\*\*Figure 8: Absorbance at 365 nm of 0.1 mg/mL avobenzone solution over 150 minutes with (blue) and without (orange) UV exposure in a Formlabs chamber.\*\*  
  
A follow-up 80-minute exposure study was conducted on avobenzone (0.1 mg/mL), octocrylene (0.3 mg/mL), and a 1:3 mixture. The avobenzone solution absorbance decreased from 12.087 to a minimum of 3.602 at 20 minutes before fluctuating and rising to 4.994 at 80 minutes [TABLE 4, FIGURE 9]. The octocrylene solution absorbance remained stable throughout the exposure period [TABLE 5]. The avobenzone-octocrylene mixture showed a 75.4% decrease in absorbance, from 1.332 at T0 to a minimum of 0.328 at 50 minutes [TABLE 6, FIGURE 10].  
  
\*\*Table 4: Absorbance at 365 nm of 0.1 mg/mL avobenzone solution with and without UV exposure over 80 minutes.\*\*  
| Timepoint (Minutes) | UV Radiated Abs. | Non-UV Radiated Abs. |  
| :--- | :--- | :--- |  
| 0 | 12.0870 | 12.2270 |  
| 10 | 5.4360 | 12.1930 |  
| 20 | 3.6020 | 11.9470 |  
| 30 | 8.5160 | 11.7160 |  
| 40 | 5.2810 | 11.5370 |  
| 50 | 4.6700 | 11.4930 |  
| 60 | 5.0220 | 11.5070 |  
| 70 | 4.8260 | 11.3850 |  
| 80 | 4.9940 | 11.2630 |  
  
\*\*Table 5: Absorbance at 365 nm of 0.3 mg/mL octocrylene solution with and without UV exposure over 80 minutes.\*\*  
| Timepoint (Minutes) | UV Radiated Abs. | Non-UV Radiated Abs. |  
| :--- | :--- | :--- |  
| 0 | 0.7290 | 0.7990 |  
| 10 | 0.8060 | 0.8680 |  
| 20 | 0.8230 | 0.8220 |  
| 30 | 0.8090 | 0.8160 |  
| 40 | 0.7000 | 0.8260 |  
| 50 | 0.8150 | 0.8680 |  
| 60 | 0.8320 | 0.8290 |  
| 70 | 0.7950 | 0.8440 |  
| 80 | 0.7850 | 0.8090 |  
  
\*\*Table 6: Absorbance at 365 nm of an avobenzone-octocrylene mixture with and without UV exposure over 80 minutes.\*\*  
| Timepoint (Minutes) | UV Radiated Abs. | Non-UV Radiated Abs. |  
| :--- | :--- | :--- |  
| 0 | 1.3320 | 1.3200 |  
| 10 | 0.4510 | 1.3820 |  
| 20 | 0.6410 | 1.3660 |  
| 30 | 0.6250 | 1.0320 |  
| 40 | 0.3560 | 1.3140 |  
| 50 | 0.3280 | 1.2690 |  
| 60 | 0.3310 | 1.2870 |  
| 70 | 0.3320 | 1.3210 |  
| 80 | 0.3640 | 1.3050 |  
  
\*\*Figure 9: Absorbance at 365 nm of UV-exposed avobenzone, octocrylene, and mixture solutions over 80 minutes.\*\*  
\*\*Figure 10: Absorbance at 365 nm of UV-exposed avobenzone and avobenzone-octocrylene mixture solutions over 80 minutes.\*\*  
  
### Photoprotective Effect of PLGA Microsphere Encapsulation  
  
The ability of PLGA microspheres to protect avobenzone from photodegradation was assessed. In an initial 45-minute UV exposure experiment, free avobenzone (0.1 mg/mL) absorbance at 365 nm decreased to 12.7% of its initial value [TABLE 7]. In contrast, avobenzone encapsulated in AV9 microspheres retained 67.6% of its initial absorbance under the same conditions [TABLE 8, FIGURE 11, FIGURE 12].  
  
\*\*Table 7: Absorbance of 0.1 mg/mL free avobenzone solution exposed to UV over 45 minutes.\*\*  
| Timepoint (Minutes) | 365 nm Abs. | Abs. % |  
| :--- | :--- | :--- |  
| 0 | 9.879 | 100.0 |  
| 15 | 2.242 | 22.7 |  
| 30 | 1.404 | 14.2 |  
| 45 | 1.252 | 12.7 |  
  
\*\*Table 8: Absorbance of encapsulated avobenzone in AV9 microspheres exposed to UV over 45 minutes.\*\*  
| Timepoint (Minutes) | 365 nm Abs. | Abs. % |  
| :--- | :--- | :--- |  
| 0 | 5.202 | 100.0 |  
| 15 | 2.608 | 50.1 |  
| 30 | 3.211 | 61.7 |  
| 45 | 3.518 | 67.6 |  
  
\*\*Figure 11: Percent absorbance remaining for free 0.1 mg/mL avobenzone solution after UV exposure.\*\*  
\*\*Figure 12: Percent absorbance remaining for avobenzone encapsulated in AV9 microspheres after UV exposure.\*\*  
  
The effect of PLGA concentration on photoprotection was further investigated using formulations AV12 (+20% PLGA), AV13 (+30% PLGA), AV14 (+5% PLGA), and AV15 (+10% PLGA). Samples were exposed to UV radiation for up to 50 minutes, and absorbance was measured at 365 nm [TABLE 9, FIGURE 13]. Formulations AV15 and AV12 showed the highest stability, with absorbance values remaining relatively constant or increasing slightly through the 20-minute timepoint. In contrast, formulation AV13 (+30% PLGA) showed a rapid decline in absorbance from 2.175 at T0 to 0.226 at 20 minutes. Formulation AV14 (+5% PLGA) also showed a decrease in absorbance from 1.978 at T0 to 1.551 at 20 minutes.  
  
\*\*Table 9: Absorbance at 365 nm for avobenzone-loaded microspheres with varying PLGA concentrations after UV exposure.\*\*  
| Timepoint (Minutes) | AV14 (+5% PLGA) Abs. | AV15 (+10% PLGA) Abs. | AV12 (+20% PLGA) Abs. | AV13 (+30% PLGA) Abs. |  
| :--- | :--- | :--- | :--- | :--- |  
| 0 | 1.978 | 1.889 | 1.189 | 2.175 |  
| 10 | 1.640 | 1.991 | 1.041 | 1.112 |  
| 20 | 1.551 | 1.935 | 1.167 | 0.226 |  
| 30 | 2.044 | 1.134 | 0.316 | 1.658 |  
| 40 | 1.590 | 2.406 | 0.759 | 2.423 |  
| 50 | 1.631 | 1.624 | 0.045 | 3.478 |  
  
\*\*Figure 13: Degradation profiles of avobenzone-loaded microspheres with increased PLGA concentrations.\*\*  
  
#### Most Impactful Features  
\* \*\*PLGA Concentration (+10% and +20%)\*\* — Reduced initial photodegradation. Formulations AV15 and AV12 maintained higher absorbance values for up to 20 minutes compared to the +5% and +30% formulations.  
\* \*\*PLGA Concentration (+30%)\*\* — Increased photodegradation. Formulation AV13 showed a rapid decrease in absorbance, dropping from 2.175 to 0.226 within 20 minutes.  
  
### In Vitro Drug Release from Avobenzone-Loaded Microspheres  
  
The in vitro release of avobenzone from microsphere formulations AV10 and AV15 was monitored over a 56-hour period. The percent of drug released at each timepoint and the cumulative release were calculated [TABLE 10, FIGURE 14, FIGURE 15]. Formulation AV10 exhibited an initial burst release of 12% at T0, followed by sustained release, reaching a cumulative release of 113% by 56 hours. Formulation AV15 showed a similar initial burst of 14% but had a slower overall release profile, reaching a cumulative release of 74% at the 56-hour timepoint.  
  
\*\*Table 10: Cumulative percent release of avobenzone from AV10 and AV15 microspheres over 56 hours.\*\*  
| Timepoint (Hours) | AV10 Cumulative Drug Released % | AV15 Cumulative Drug Released % |  
| :--- | :--- | :--- |  
| 0 | 12% | 14% |  
| 2 | 27% | 16% |  
| 4 | 36% | 21% |  
| 6 | 49% | 26% |  
| 8 | 58% | 28% |  
| 24 | 58% | 28% |  
| 26 | 74% | 40% |  
| 28 | 74% | 44% |  
| 30 | 86% | 51% |  
| 32 | 86% | 51% |  
| 48 | 86% | 59% |  
| 50 | 90% | 59% |  
| 52 | 102% | 63% |  
| 54 | 106% | 72% |  
| 56 | 113% | 74% |  
  
\*\*Figure 14: Percent of avobenzone released from AV10 and AV15 microspheres at each timepoint over 56 hours.\*\*  
\*\*Figure 15: Cumulative percent of avobenzone released from AV10 and AV15 microspheres over 56 hours.\*\*

# Conclusion

Based on the experimental data, encapsulating avobenzone in poly(lactic-co-glycolic acid) (PLGA) microspheres is a viable strategy for improving its photostability. Initial methodological development revealed that early UV-B light sources induced degradation too slowly for effective analysis, leading to the adoption of a more intense Formlabs UV Cure Chamber. With this new source, free avobenzone in DMSO exhibited significant degradation, with maximum absorbance loss observed between 20 and 60 minutes of exposure, followed by an unexpected increase in absorbance at longer timepoints.  
  
The core finding of this work is that PLGA microspheres can protect avobenzone from UV degradation, with the degree of protection being dependent on the polymer concentration. Formulations with a 10% (AV15) and 20% (AV12) increase in PLGA concentration provided enhanced protection against degradation for up to 20 minutes of UV exposure. In contrast, formulations with lower (+5% PLGA, AV14) and higher (+30% PLGA, AV13) polymer content appeared to degrade immediately upon exposure, suggesting an optimal range for the polymer-to-drug ratio.  
  
Furthermore, spectral analysis confirmed that octocrylene is stable under UV radiation and that its absorbance peak at 310 nm is distinct from avobenzone's at 357 nm, allowing for analysis in mixed solutions. While a 1:3 mixture of avobenzone to octocrylene demonstrated some protection, significant avobenzone degradation still occurred. Drug release studies also confirmed that avobenzone is successfully released from the microsphere formulations over a 56-hour period. In summary, the encapsulation of avobenzone in PLGA microspheres, particularly with optimized polymer concentrations, offers a promising approach to mitigate UV-induced degradation.